No. 829,992. PATENTED SEPT. 4, 1906.

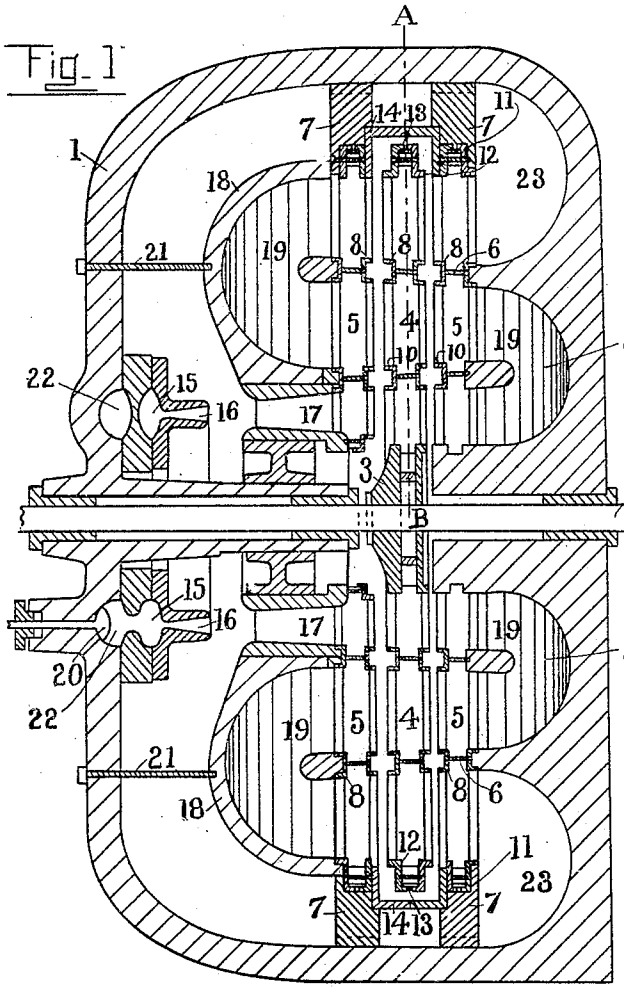
W. F. NEWMAN.

TURBINE.

APPLICATION FILED APR. 24, 1905.

4 SHEETS—SHEET 1.

Fig. 1



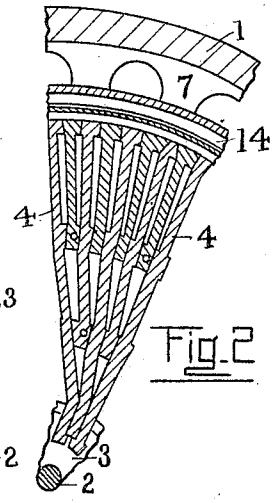


Fig. 2

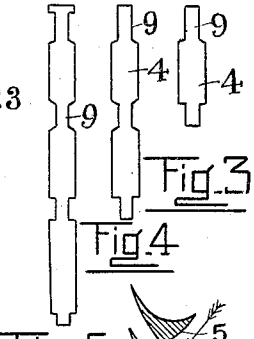


Fig. 3

Fig. 4

Fig. 5

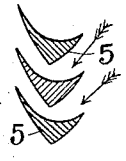


Fig. 6

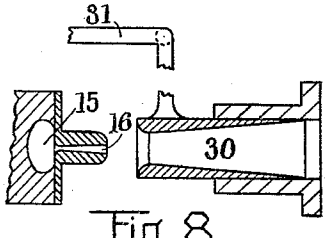


Fig. 8

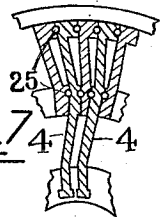


Fig. 7

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Atty.

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4 SHEETS—SHEET 2.

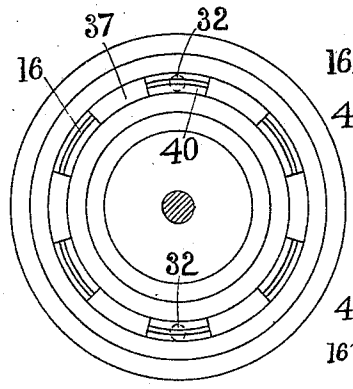

Fig: 10

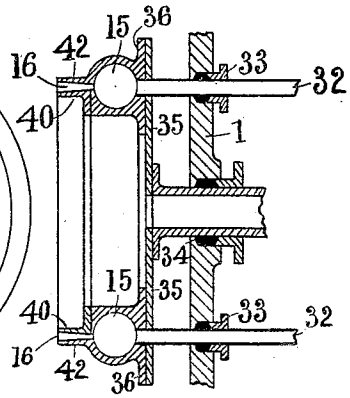

Fig: 9

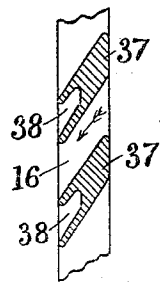

Fig: 11

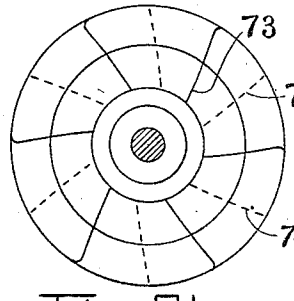

Fig: 21

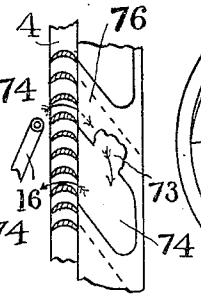

Fig: 20

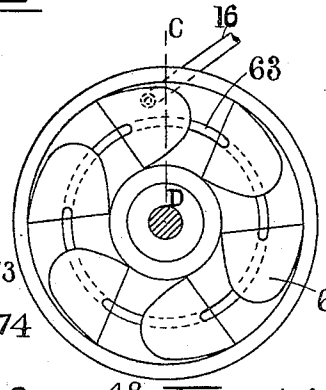

Fig: 14

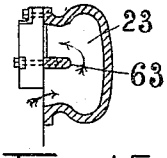

Fig: 15

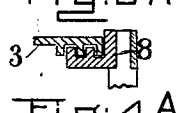

Fig: 3A

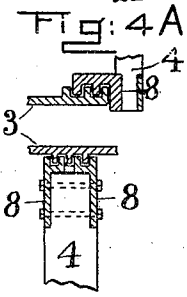

Fig: 4A

Fig: 5A

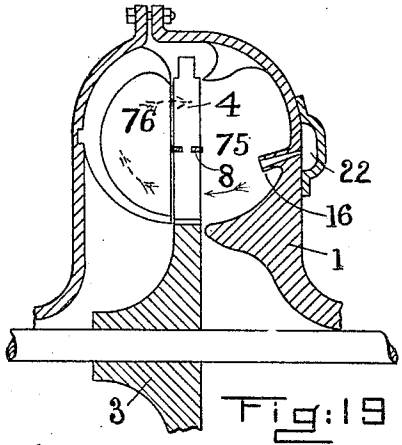

Fig: 19

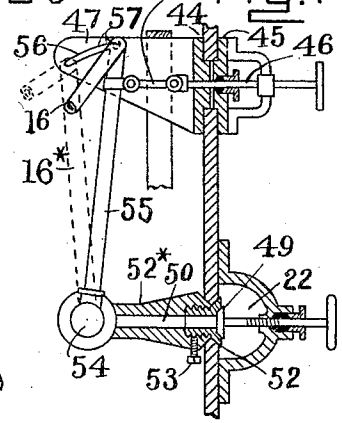

Fig: 12

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No. 829,992. PATENTED SEPT. 4, 1906.

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TURBINE.

APPLICATION FILED APR. 24, 1905.

4 SHEETS—SHEET 3.

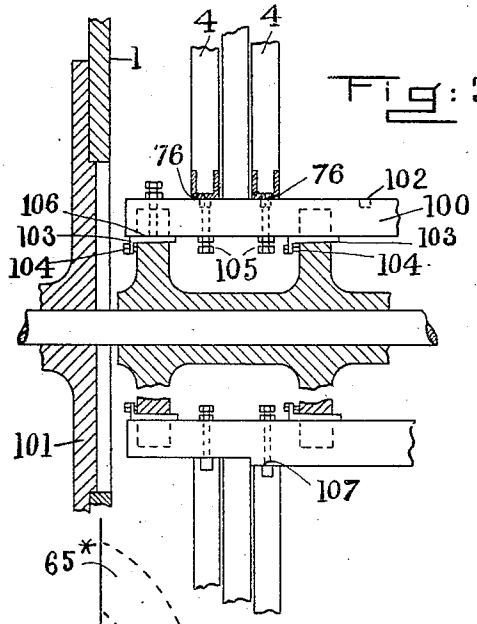

Fig: 26

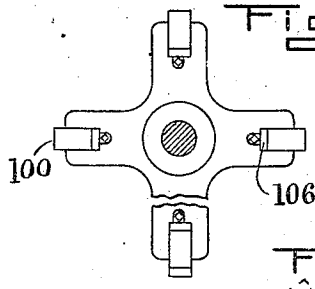

Fig: 27

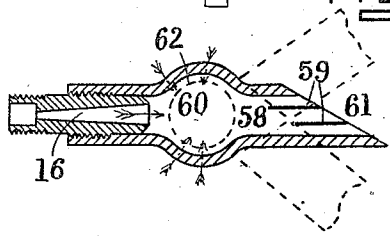

Fig: 13

Fig: 16 B

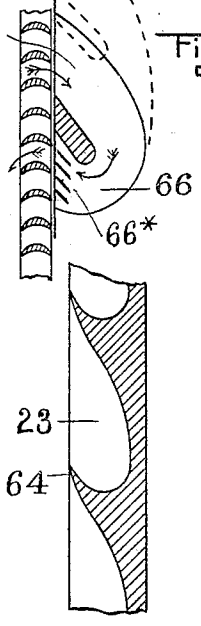

Fig: 16

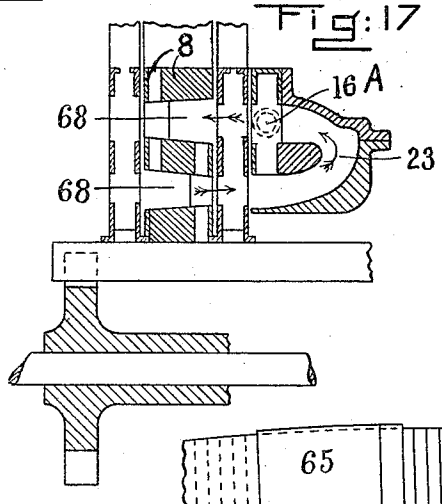

Fig: 17

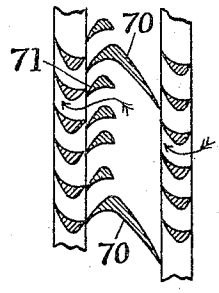

Fig: 18

Fig: 16 A

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TURBINE.

APPLICATION FILED APR. 24, 1905.

4 SHEETS—SHEET 4.

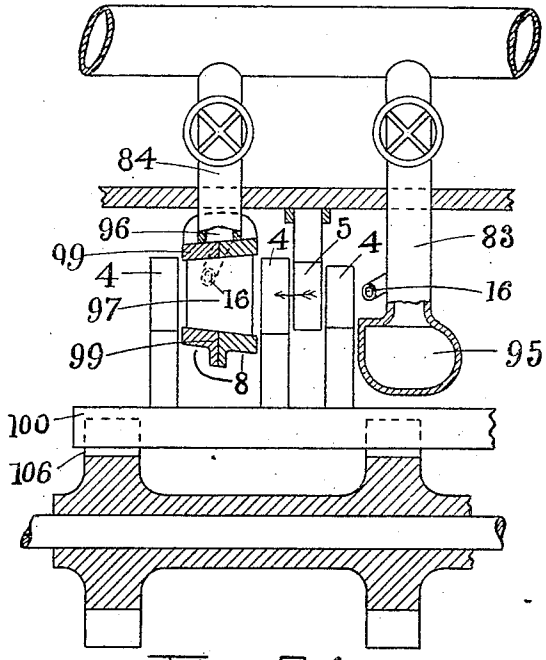


Fig: 24

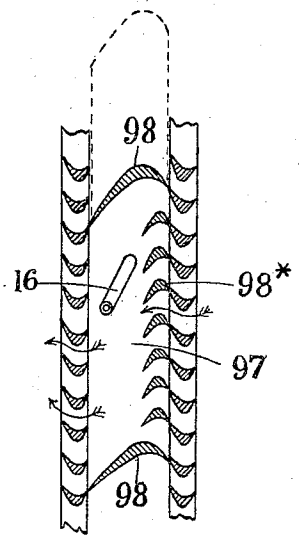
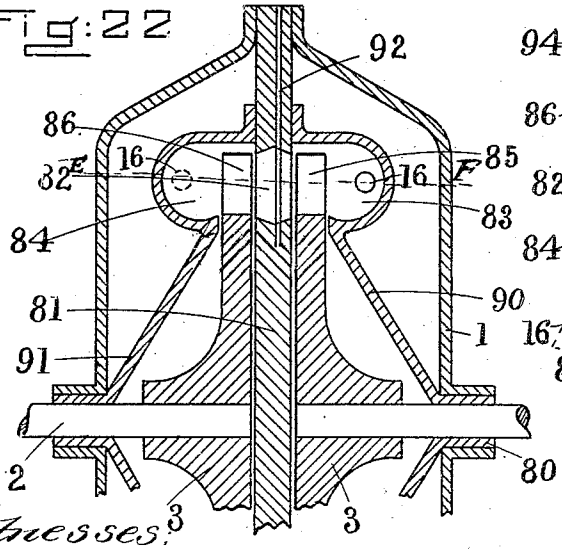


Fig: 25

Fig: 22



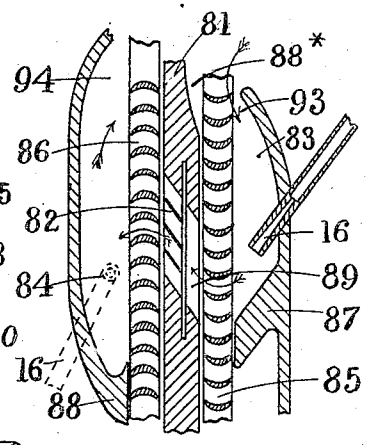


Fig: 23

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C. J. Kesler

Inventor

William F. Newman

By James L. Norris

Atty

UNITED STATES PATENT OFFICE.

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TURBINE.

No. 829,992. Specification of Letters Patent. Patented Sept. 4, 1906.

Application filed April 24, 1905. Serial No. 257,254.

To all whom it may concern:

Be it known that I, WILLIAM FARISH NEWMAN, engineer, a subject of the King of Great Britain, residing at No. 31 Arundel Terrace, Forest Lodge, near Sydney, in the State of New South Wales, Commonwealth of Australia, have invented certain new and useful Improvements in Turbines, of which the following is a specification.

This invention relates to improvements in turbines driven by steam or other elastic fluid, and has been devised with the view to obtaining greater efficiency than has hitherto been possible in turbines of the class mentioned.

My invention has reference more particularly to the construction of the fixed and moving vanes, to the provision for expansion-spaces for returning the steam, to the injection of the exhausted or partially-exhausted steam by means of high-pressure steam, and to the construction of adjustable nozzles, together with other details, as hereinafter more particularly described.

I will now refer to the accompanying drawings in order that my invention may be clearly comprehended.

Figure 1 is a longitudinal section of a steam-turbine constructed according to this invention. Fig. 2 is a section through the line A B, Fig. 1, illustrating the construction and arrangement of the vanes. Figs. 3, 4, and 5 illustrate three of the vanes in detail. Figs. 3^A, 4^A, and 5^A illustrate three ways in which concentric rings may be used to prevent leakage of steam between the moving and fixed vanes and at the hub or periphery of the wheels. Fig. 6 is a sectional plan, on an enlarged scale, illustrating three vanes. Fig. 7 is a section illustrating a modified arrangement of vanes as applied to a reversing-turbine. Fig. 8 is a longitudinal section of an adjustable nozzle or injector. Fig. 9 is a longitudinal central section through a modified construction of adjustable nozzle; Fig. 10 an elevation, and Fig. 11 a detail, thereof. Fig. 12 is an elevation, partly in section, illustrating a modified arrangement of adjustable hinged nozzle. Fig. 13 is a longitudinal section of a combined steam and injector nozzle for using steam divergently. Fig. 14 is a front elevation of parts forming steam pockets or guides, passages, or return spaces; and Fig. 15, a section through the line C D, Fig. 14. Fig. 16 is a detail sectional plan of divergent pieces on an enlarged scale. Fig. 16^A is a front elevation illustrating another form of return-passage, while Fig. 16^B is a detail of same. Fig. 17 is a longitudinal section showing decreasing passages between the rings. Fig. 18 is a detail in section, showing relation of fixed and moving vanes in Fig. 17. Fig. 19 is a central longitudinal section, Fig. 21 a front elevation, and Fig. 20 a detail plan, illustrating a further adaptation of the injector action of my nozzles and reversing-pockets. Fig. 22 is a longitudinal section, and Fig. 23 a section through the line E F, Fig. 22 illustrating another form of reversing-turbine with injector action. Figs. 24 and 25 are respectively a longitudinal elevation, partly in section, and detail through fixed and moving vanes of a turbine internally steam-heated. Fig. 26 is a longitudinal section, and Fig. 27 a partial end elevation, illustrating means whereby a shaft, hub, drum, and moving vanes may be removed without disturbing other parts of turbine.

The same numerals refer to the same or corresponding parts.

Referring to Figs. 1 to 6, 1 is the turbine-casing. 2 is the shaft, on which is keyed or otherwise secured the hub 3, carrying radial moving vanes 4. The fixed vanes 5 are of similar construction, but are set at divergent angles to the moving vanes and are secured to the casing by means of screws 6 and to perforated flanges 7. The vanes, both fixed and moving, are divided by pairs of concentric rings 8, held together by screws or otherwise to form the passages for the steam; but I may use single rings in attaching the vanes to the casing, hub, or return passages or pockets. These rings 8 preferably coincide with recesses 9, made in the sides of the vanes to receive them, and are preferably provided with flanges 10, which may incline at angles other than a right angle to protect the moving and fixed vanes from coming into contact with each other and to act as guides for the steam. I may, however, use the rings with vanes which are not recessed, and I may use rings of hollow section. The moving vanes, which are rigidly secured in or to the hub 3, preferably extend to three concentric rows, (or the maximum number, as the case may be,) additional vanes being interposed between each long vane in the sec-

ond row and between each long and intermediate vane in the third row, the whole being held together by the several concentric rings 8. It is evident, however, that the vanes may be built up in concentric rows of short vanes instead of long vanes, with short vanes interposed and held together by rings, thereby facilitating construction and inspection. The rings also may be made in segments. The vanes are preferably dovetailed into one another at the periphery of the wheels, at the hub, and where held by the rings, as shown in Fig. 2, and they are preferably set an at angle to a radial line, so that the egress of the steam is of a less sectional area than in the present turbines. The outer rings 12 may have flanges 11 for the purpose of holding packing or a ring or ribbon of metal 13 between them. Instead of the outer rings 12 I may use a light flanged band or ribbon wound round between the flanges with wire of a high tensile strength. 14 is a steam-tight flanged ring or rings inclosing the moving vanes, or the peripheral fixed rings may have flanges continued over the moving vanes, or in some cases these rings 14 may be dispensed with. 15 is a steam-ring divided into sections or compartments to supply steam to the nozzles onto the vanes 5 through the passage 17, which may be of the same or an increasing sectional area. The nozzle 16 and passage 17 are each constructed of two preferably-flanged rings, forming together a circular conical nozzle. 18 is the inner casing, and 19 represents divergent guides in the expansion-spaces 23. 20 is valve to steam-ring 15. 21 is screw bearing on the inner casing.

The operation of the turbine illustrated in Figs. 1 to 6 is as follows: The ring 22 is connected to the high-pressure steam, the said ring being in communication with the ring 15, controlled by the valve 20. The steam issuing from the nozzle or nozzles 16 enters the passage 17, which acts as an injector and impinges against the row of fixed vanes 5 nearest the center, and is diverted onto the vanes 4, causing the wheel to rotate. The steam leaves the moving vanes at a reverse angle and enters the next row of fixed vanes. The steam then passes into the first expansion-space 23, in which are a number of guides 19, and then through the second row of fixed and moving vanes into the second expansion-space before entering the third row of fixed and moving vanes, after which it passes through the perforated flanges 7 back toward the nozzles 16 and exhaust. If desired, I may use live-steam nozzles in one or more of the return-passages or expansion-spaces 23, and the passage 17 may be made adjustable to the nozzle 16. I may dispense with the ports 17 and cause the steam from the nozzles 16 to impinge directly onto the vanes.

In Fig. 7 the vanes 4 are held together by keys 25, which may be of various cross-section. In this form as applied to a reversing turbine a separate nozzle is necessary for each row of vanes, so as to operate the wheel in opposite directions as desired. The keys 25 are especially suitable for high-speed motors and are fixed into recesses in each vane or between the vanes, where they are held together by the rings 8. These keys assist to form a steam-tight joint and to resist the centrifugal action.

In Fig. 8 the passage 30 is made adjustable in relation to the nozzle by means of the lever 31, the operating-handle of which extends outside the casing, and it may be brought up close to the nozzle, and thus shut off the injector action. Although I show fixed vanes or wheels of vanes attached at the openings to the return or expansion spaces in the ends of the casing, I may in some cases dispense with them or have them to extend over part of the opening. I may also use nozzles to impinge the steam directly onto moving vanes.

In Figs. 9 to 11, 16 represents nozzles; 15, steam-supply chamber; 32, steam-pipes; 33, glands; 34, boss; 1, casing; 35, supports, and 36 flanges. 37 represents blocks or guides, and 38 recesses therein, the nozzles 16 being formed between the guides. The nozzles 16 preferably first converge and then diverge toward their outlets. The part 40 of nozzle is preferably made in one piece with its supports 35 and boss 34. The part 42 of the nozzle is preferably flanged at 36 and made steam-tight with the supports 35 and part 40. The steam-pipe 32 preferably passes through a gland 33 in the casing and is suitably connected to the steam-supply. The whole of the nozzle is made adjustable to the vanes or to the passage 17, Fig. 1, and may be operated by a suitable lever or the like. It will be seen that the parts 40 and 42 form between them the nozzles 16 and steam-supply chamber 15 and may be blocked into sections, as shown clearly in Figs. 10 and 11.

In Fig. 12 a nozzle is shown adjustable by means of slides 44 45 and linked spindle 46. 47 is a slotted piece at right angles to slide 44 for holding the nozzle 16 in position. 22 is a steam-supply chamber, and 49 a valve to admit steam to inlet 50. The valve 49 has a conical seating 52, the rear of which has a seating in the casing or steam-chamber and is screwed into part 52*, which may be flanged to make it more rigid. The seating 52 is also held by set-screw 53. 54 is an elbow, preferably set at right angles to passage of valve 49. 55 is a connection from the elbow 54 to the nozzle 16. The link 48 connects spindle 46, nozzle 16, and steam connection 55. 5[illegible] is slot in piece 47, and 57 is pin toward the rear of nozzle engaging in said slot. The dotted lines in Fig. 12 show a ring connecting

a number of jointed nozzles. The dotted lines at 16* show another position of the nozzle operated by the spindle 46 and link 48. The nozzle may also be moved circumferentially by means of the slides 44 and 45 and kept in position by springs, ratchets, screw, or other similar means.

In Fig. 13 is shown a steam and injector nozzle for using steam divergently. The injector-passage 58 has opening preferably at 60, the steam passing through and out at 61. The passage 58 may be curved, as shown in dotted lines, instead of being straight and need not necessarily be of circular section or of the same area throughout, and the bulge or swelling 62 may be dispensed with. The passage may have suitable guides 59.

In Figs. 14 and 15 are shown a number of parts 64, forming steam pockets or guides in passages or return-spaces, such as at 23, Fig. 1. These pockets may have blocks or pieces in them, as shown at 76, Fig. 20.

Fig. 16 is a sectional plan of divergent parts or pieces on an enlarged scale. The pockets 23 are preferably divided into concentric spaces by the circular ring 63, Figs. 14 and 15, and 8, Fig. 1. The pockets need not be evenly spaced or of uniform area and may be of other forms, such as 23, Figs. 1 and 17. The divergent parts 64 may be made adjustable to each other, so as to increase or decrease their areas.

Fig. 16^A and Fig. 16^B illustrate another form of return-passage. The steam enters at 65 and thence into 66, which has preferably a narrower radial diameter than at the inlet 65. The guide-vanes 66* are attached or secured in or to the steam-exit 66. I may use any of the steam-pockets such as are shown in Figs. 16^A and 16^B reversely, the steam leaving at 65*, such as shown in dotted lines in Fig. 16^B.

In Figs. 17 and 18 are shown passages 68 of decreasing area, being formed by the concentric rings 8. I preferably use the larger fixed vanes or guide-pieces 70 to divide the passages 68 into sections. Smaller vanes 71 may be placed between the larger, as in Fig. 18. The guides 70 may be attached to a ring of vanes, and they need not necessarily be of the shape shown. The return-passages 23 may have nozzles 16^A attached or formed in them instead of guide-vanes. The fixed vanes or rings 8 may be blocked between the passages, as shown in dotted lines in Fig. 25.

Referring to Figs. 19 to 21, 3 is hub; 22, steam-ring; 16, nozzles; 1, casing; 4, moving vanes or wheel. 73 is channel leading into pocket 74; 75, pocket of increased area; 8, rings dividing the moving vanes. 76 is a block in the pocket 74. The action of this form is that the steam leaving the nozzle 16 at a high velocity enters the vanes of the turbine-wheel, preferably nearest the hub, at a divergent angle and reverses therefrom into the passage or channel 73, preferably under the block 76, into the pocket 74 and is there reversed or expanded, preferably through guide-vanes, again into the moving wheel and then into the pocket 75, when it may be again returned into another section of the moving wheel.

In Figs. 22 and 23 are views of a reversing-turbine using an injector action. 2 is shaft; 3, hubs; 1, casing; 80, bearing; 81, disk with guide-vanes 82. 83 84 are passages for steam to leave or enter reverse-moving wheels 85 86. 87 88 are guide-pieces and reversing-pieces, respectively, in the passages 83 84. 16 is steam-nozzle. 88* is a curved recess in disk 81, or it may be an opening, as shown at 89. 90 and 91 are supports of passages 83 and 84, carried toward the center or axial line. 92 is a slot of any suitable section in the disk 81. The passages preferably contract at 93 and 94. In operation, the steam passing through wheel 85 from a nozzle 16 passes through opening 89 in disk 81, preferably with guides, into vane-wheel 86, revolving in an opposite direction, and then into passages 84, where it is stopped by the block 88 and either exhausts at 94 or is again passed through wheel 86 by converging passage 94 or by guides, thence again through opening in disk 81, similar to 89, and then into wheel 85. The disk may be provided with shutters, or it may have a circular cut-off. In some cases I may use the reversing-wheel and disk without passages 83 84.

In Figs. 24 and 25 is shown a turbine internally steam-heated. 95 96 are live-steam channels or rings; 83 84, passages for steam to rings from steam-supply. 98 represents large fixed vanes. 8 represents concentric rings. In this case the steam enters the rings 95 and 96 through the connections 83 84 and passes from them preferably to divergent nozzles 16 into the first moving wheel of vanes 4, passing thence, preferably through fixed vanes 5, into another moving wheel of vanes 4. The steam thence passes into the steam-heated passage 97, formed by the concentric rings 8 and large guides 98 and fixed vanes or parts 98*, into the vane-wheel 4. The steam-rings 95 and 96 may have cut-offs. If I arrange my fixed vanes 98* as shown in Fig. 25, I may attach nozzles 16 on the steam-ring 96 or I may dispense with nozzles and use vanes only or use nozzles only.

In Figs. 26 and 27, 100 represents keys; 1, casing; 101, removable covers on ends of casing. 4 represents moving wheels; 76, block, preferably on the inner rings of moving vane-wheels; 102, recess for block in keys 100. 103 represents smaller keys to lift and hold in position the larger keys 100. 104 represents set-screws for keys 103, and 105 represents adjusting-screws in keys 100 to the wheels. To remove the moving wheels, the covers are taken off at one or both ends. The keys 103 are then withdrawn, thereby allowing the

large keys 100 to drop farther into the recesses 106 and release them from the inner rings of the moving wheels. The large keys can then be withdrawn, also the shaft and hubs, leaving the moving wheels free to be taken out. In some cases I may use springs to hold the keys 100 to the wheels. The large keys may be stepped, as at 107.

Although I have described my improvements in many instances as employed with an injector-nozzle, I would have it understood that I do not restrict myself to such, as I may use live steam directly on the vanes or in passages or from the passages.

What I claim, and desire to secure by Letters Patent of the United States, is—

1. In elastic-fluid turbines, a hub or drum carrying radial vanes connected together by concentric rings 8 which are attached to the sides of said vanes, substantially as set forth.

2. In elastic-fluid turbines, a hub or drum having radial vanes extending to the periphery thereof, and held together by concentric rings attached to the sides of the vanes, shorter vanes interposed between said vanes secured between said concentric rings, substantially as set forth.

3. In elastic-fluid turbines, a hub or drum having radial vanes extending to the periphery thereof, and recesses on both sides of the vanes in combination with concentric rings fitting tightly within said recesses, substantially as set forth.

4. In elastic-fluid turbines, a hub or drum having radial vanes extending to the periphery thereof and held together by concentric rings attached to the sides thereof, said vanes being dovetailed into each other, substantially as set forth.

5. In elastic-fluid turbines, a hub or drum having radial vanes extending to the periphery thereof and held together by concentric rings attached to the sides thereof, said vanes being secured by keys, substantially as set forth.

6. In elastic-fluid turbines, a hub or drum having radial vanes extending to the periphery thereof and having adjacent thereto guide-vanes, passages, pockets, ports, curved recessed disks with ports and shutters therein, an injector-nozzle in a working line therewith to return the elastic fluid with increased energy through another stage or section of said vanes, substantially as set forth.

7. In elastic-fluid turbines, a hub or drum having radial vanes extending to the periphery thereof, and passages, nozzles, pockets, ports and disks, the combination therewith, of means for adjusting the injector-nozzles to said vanes, passages, pockets, ports and disks, substantially as set forth and as illustrated.

8. In elastic-fluid turbines, a hub or drum having radial vanes extending to the periphery thereof, the combination with injector-nozzles, of shutters for cutting off the elastic fluid, substantially as set forth.

9. In elastic-fluid turbines, a hub or drum having radial vanes extending to the periphery thereof and provided with passages, pockets, ports and disks, an injector-nozzle situated in line with an injection-passage for conveying the elastic fluid to the vanes, passages, pockets, ports and disks, and means for adjusting said injection-passage to the nozzle, substantially as set forth.

10. In elastic-fluid turbines, a hub or drum having radial vanes extending to the periphery thereof, an adjustable injector-nozzle attached to a hinged fluid-supply pipe, substantially as set forth.

11. In elastic-fluid turbines, a hub or drum having radial vanes extending to the periphery thereof, an adjustable injector-nozzle attached to the fluid-supply pipe, said pipe being adapted to slide in steam-tight connections, substantially as set forth.

12. In elastic-fluid turbines, a hub or drum provided with axial recesses, large keys fitting said recesses and carrying radial vanes, and smaller keys to lift and hold said larger keys, substantially as set forth, and as illustrated.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

WILLIAM FARISH NEWMAN.

Witnesses:

CHARLES EDWARD GRAHAM,

HENRY WATCHORNE CLARKE.